Ohio Agricultural Experiment Station.

BULLETIN 52.

.....AND.....

TWELFTH ANNUAL REPORT,

FOR 1893.

WOOSTER, O., DECEMBER, 1893.

The **Bulletin of this Station is sent free to all residents of the State who request it. Persons who receive duplicate copies of the Bulletin, or who do not care to receive any, are requested to notify the Station, as the edition is not sufficient to supply the urgent demand for it.** All correspondence should be addressed to EXPERIMENT STATION, *Wooster, Ohio.*

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TWELFTH ANNUAL REPORT

OF THE

OHIO AGRICULTURAL

EXPERIMENT STATION,

FOR 1893.

PRINTED BY ORDER OF THE STATE LEGISLATURE.

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OHIO AGRICULTURAL EXPERIMENT STATION.

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THE GOVERNOR OF THE STATE,
THE DIRECTOR OF THE STATION, } .....*Ex-Officio.*

OFFICERS OF THE BOARD.

SETH H. ELLIS.....President.
R. H. WARDER.....Secretary.
BERTHA E. WILDMAN.....Treasurer.

STATION STAFF.

CHARLES E. THORNE.....Director.
WILLIAM J. GREEN.....Horticulturist and Vice-Director.
J. FREMONT HICKMAN, M. A. S.....Agriculturist.
FRANCIS M. WEBSTER.....Entomologist.
BERTHA E. WILDMAN.....Bursar.
EDWIN C. GREEN.....Assistant Horticulturist.
F. J. FALKENBACH.....Chemist and Meteorologist.
J. S. HINE, B. Sc.....Superintendent N. W. Sub-Station.

PUBLICATIONS.

The bulletins of this Station are issued at irregular intervals. They are not republished in the annual report, but are consecutively paged and a complete index for the year's issues is published in the annual report, which constitutes the final issue for each year. Persons who preserve their bulletins may have them bound in cloth, by returning them to the Station with thirty cents per volume for binding and postage.

Announcement.

The Ohio Agricultural Experiment Station is organized under an act of the General Assembly of Ohio, passed April 17th, 1882, and supplemented by an act of Congress approved March 2, 1887.

The Station is prepared to test new varieties of grains, fruits and garden vegetables; to examine seeds that are suspected of being unsound or adulterated; to identify and name grasses, weeds and other plants; to identify insects and suggest measures for the control of such as are injurious, and to give advice concerning the prevention of the fungoid diseases which affect vegetation.

The Station is not prepared to furnish analyses of chemical or commercial fertilizers, as in Ohio that work is performed under direction of the Secretary of the State Board of Agriculture at Columbus; but the Station will at all times respond to requests for advice concerning the use of such fertilizers.

The Station is not prepared to examine foods and dairy products suspected of adulteration, as that work is provided for in the Ohio Dairy and Food Commission, whose headquarters are at Columbus.

The Station is not at present prepared to offer advice or treatment for contagious animal diseases, but would refer all seeking such assistance to the Ohio Live Stock Commission, at Columbus.

Any citizen of Ohio has the right to apply to the Station for any information it can give, and all such applications will receive prompt attention.

Visitors to the Station are always welcome.

Address all communications to

EXPERIMENT STATION, *Wooster, Ohio.*

Twelfth Annual Report.

REPORT OF THE BOARD OF CONTROL.

To Hon. WILLIAM MCKINLEY, *Governor of Ohio:*

SIR: The Board of Control of the Ohio Agricultural Experiment Station submits herewith its annual report for the year ending December 31, 1893.

The work of the Station has gone on quietly and effectively as usual and with great advantage to the State at large.

The bulletins published have been of the same high order of useful knowledge, which has hitherto distinguished the Ohio reports.

The able and faithful work accomplished continues to reflect great credit on the State and to maintain the high rank of the Ohio Station among those of other states.

The bulletins on sub-irrigation and insect destruction and fungicides are of very great value, and worth to the State at large many times the cost of the Station.

IMPROVEMENTS.

In our last annual report it was stated that a portion of the funds donated by Wayne county to secure the location of the Station had been held in the State Treasury in consequence of a doubt on the part of the Auditor of State, arising from the adverse decision of the Supreme Court respecting the constitutionality of the law under which the Station had been moved to Wayne county. By a special resolution passed March 1st, the General Assembly directed the State Auditor and Treasurer to honor the requisitions of the Board of Control on this fund, and under the advice of the Attorney General the funds were released and are being expended by the Station in the improvement of the Station farm.

These improvements include the completion of the greenhouses and insectary, plans of which were given in the last report; the construction of about 26 miles of tile drain; the inclosing of the farm with a substantial fence; the remodeling of one of the barns on the farm and the purchase of three small tracts of land adjoining the farm, which were needed to provide convenient access to the main buildings and for residence purposes.

SPECIAL APPROPRIATIONS.

On account of the unsettled condition of affairs resulting from the obstructive litigation referred to in our last report, and by advice of members of the finance committee of the General Assembly, the request for appropriations for permanent improvements made in that report was withdrawn, and the following items were substituted, and were granted in full:

Sub-station for field experiments	$1,000 00
Live stock	4,350 00
Implements and farm machinery	1,794 00
Supplies	456 00
Special work in entomology	400 00
Fees of architect (on plans for main building)	1,000 00
Expenses of Board of Control (including deficiency)	715 93
Total	$9,715 93

The first item has been expended in the preparation for experiment of the tract in Fulton county, described in our last report. It is expected that most of this land will be placed under experimental cropping during the coming season.

Of the second item, a part has been expended in the purchase of stock cattle, but the major portion is being held with the view of purchasing small herds of pure bred cattle and sheep, representing the principal breeds found in the State. It is hoped that the various associations of breeders will assist in the selection of these cattle, and therefore the purchase has been delayed until they should have opportunity to take action.

The third and fourth items are being expended in the equipment of the farm and gardens with implements and machinery, including harness and similar supplies.

The fifth item is being expended in the field study of outbreaks of injurious insects as they occur in various parts of the State, full details of which will be found in the report of the Station Entomologist.

THE PRESENT STATUS.

The Court of Common Pleas has held that the law of estoppel applies to all who voted in favor of levying a tax on the county to secure the location of the Station, and this tax is now being regularly collected and the interest on the bonds issued in anticipation of the tax is being paid. With these facts in view there can no longer be any question as to the permanency of the Station's location in Wayne county. The county is faithfully fulfilling its part of the contract with the State, and as a very large portion of the work of the Station is of equal value to all the farmers of the State it is but simple justice that the State should complete the Station's equipment.

FURTHER EQUIPMENT NEEDED.

The Station as yet possesses no building for its general work, the plans for such a building having been temporarily laid aside for reasons given in our last report. It is at present occupying for this purpose the upper floors of a business block in town, situated a mile from the farm and altogether insufficient for the work required. The Station's valuable books and museum collections, many of which cannot be duplicated, are exposed to loss by fire, and its officers are necessarily so scattered and their work so divided that it cannot be carried on except at a great waste of time and energy.

Next to the need of a building for general administration is that of barns, dairy house, tool house, etc., and a residence for the director, this being required because of the impossibility of renting a sufficient number of dwellings near the farm.

The Board of Control therefore requests the appropriation by the General Assembly of $76,000, to be expended as per the following items:

Administration building	$50,000 00
Three barns and power house	17,000 00
Dairy house and equipments	3,000 00
Tool house	1,000 00
Director's residence	4,000 00
Sub-station for field experiments	500 00
Expenses of Board of Control	500 00

THE STATION AND THE STATE UNIVERSITY.

The State University and the Experiment Station have never had any organic connection, being governed by separate administrative boards. The Station, however, had occupied the farm belonging to the University, and had made thereon certain improvements. For these the University has paid the Station the sum of $5,000, which sum does not

appear in the financial statement of this year because it was not received until after the close of the fiscal year which this statement covers.

By mutual agreement, the field tests of fertilizers begun by the Station in 1888 on the University farm, are continued, through the co-operation of the agricultural departments of the two institutions.

PERSONNEL.

No change has been made in the personnel of the Station during the year, Mr. Ellis having been re-appointed as member of the Board of Control at the expiration of his term of office in the spring.

Respectfully submitted,

R. H. WARDER,
Secretary State Board of Control.

REPORT OF THE TREASURER.

To Hon. S. H. ELLIS, *President Board of Control:*

SIR: I have the honor to submit herewith a report of the receipts and expenditures of this Station for the fiscal year ending June 30, 1893.

In statement A will be found a record of the disbursements from the annual appropriation received from the United States treasury.

STATEMENT A.

THE OHIO AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES TREASURY.

Dr.

1893.		
To receipts from treasurer of the United States, as per appropriation for the year ending June 30, 1893, under act of Congress approved March 2, 1887		$15,000 00

Cr.

June 30, by salaries	$9,680 00	
" labor	1,693 20	
" supplies	1,044 88	
" freight and expressage	8 35	
" tools and implements	364 95	
" live stock	125 00	
" fencing and drainage materials	2 91	
" furniture and general fittings	496 00	
" technical apparatus and supplies	249 57	
" library	80 90	
" printing, postage and stationery	837 05	
" travel and incidentals	393 13	
" building repairs	24 06	
Total		$15,000 00

I, the undersigned, duly appointed auditor for the corporation, do hereby certify that I have examined the books and accounts of the Ohio Agricultural Experiment Station for the fiscal year ending June 30, 1893; that I have found the same well kept and correctly classified as above, and that the receipts for the time named are shown to have been $15,000.00, and the corresponding disbursement $15,000.00, for all of which proper vouchers are on file, and have been by me examined and found correct.

S. H. ELLIS,
Auditor Board of Control.

I hereby certify that the foregoing statement of account to which this is attached, is a true copy from the books of account of the institution named.

BERTHA E. WILDMAN,
Treasurer Board of Control.

The receipts and expenditures from farm produce and other items are shown in statement B:

STATEMENT B.

OHIO AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH PRODUCE FUND.

TO RECEIPTS.

Dr.

1893.			
June 30, from sales of live stock	$1,510 00		
" " milk	240 98		
" " agricultural produce	3,642 41		
" " horticultural produce	975 97		
" labor	1,195 95		
" rent	151 75		
" miscellaneous sales	825 65		
Total receipts		$8,542 71	
To balance brought forward July 1, 1892		9 85	
Total		$8,552 56	

BY EXPENDITURES.

Cr.

1893.		
June 30, for labor	$2,761 33	
" supplies	1,808 69	
" freight and expressage	416 77	
" tools and implements	358 05	
" live stock	2,063 59	
" furniture and general fittings	65 80	
" technical apparatus	85	
" printing, postage and stationery	31 83	
" travel and incidentals	45 12	
" interest	959 02	
" building repairs (material and labor)	30 73	
Total expenditures		$8,541 78
By balance carried forward		10 78
Total		$8,552 56

Of the total amount of expenditures listed in the above statement the sum of $4,466.33 was the balance due on a debt incurred by the Station in 1887, for equipment bought of the Ohio State University at the time

of the re-organization of the Station under the Hatch act. The amount of this balance is divided among the several items as follows:

Supplies	$1,134 10
Live stock	2,063 59
Implements	316 62
Interest	952 02
	$4,466 33

Of the total amount of income shown in statement B, the sum of $4,024.55 was received for live stock, produce, implements and office equipment sold at the time of the removal of the Station to Wooster.

The receipts from labor include $1,176.02, received for work done for the Ohio State University, such as teaming, mowing campus, etc., the account extending over two years previous to the removal of the Station.

Statement C is a statement of our account with the State Treasury.

STATEMENT C.

STATEMENT OF ACCOUNT OF THE OHIO AGRICULTURAL EXPERIMENT STATION WITH THE STATE TREASURY.

Date of appropriation.	Appropriation for—	Total amount to the Station's credit.	Total amount expended.	Bal. in treasury June 30, 1893.
1893	Sub-station for field experiments	$1,000 00	$192 38	$807 62
	Live stock	4,350 00	1,090 16	3,259 84
	Implements and farm machinery	1,794 00	339 85	1,454 15
	Supplies	456 00	34 60	421 40
	Special work in entomology	400 00	57 30	342 70
	Fees of architect[1]	1,000 00	1,000 00	.....
	Expenses of Board of Control	715 93	368 15	347 78
	Totals for 1893	$9,715 93	$3,082 44	$6,633 49
	Balance of appropriations for 1891 and 1892 brought forward July 1, 1892—			
1891	Fire-proof safe, office furniture and museum cases	432 75	432 75	.....
	Sub-station for field experiments with fertilizers	1,000 00	337 87	[2][662 13]
	Illustrating bulletin	381 40	114 04	[2][267 36]
1892	Spraying experiments	500 00	420 27	79 73
	Expenses of Board of Control	94 14	94 14	.....
	Totals	$12,124 22	$4,481 51	$6,713 22

(1) For plans for administration building.

(2) Owing to some change of plans and the necessary interruption and delay of work incident to the removal of the Station to its new home, these balances remained unused at the expiration of the time, during which they were available, and they therefore lapsed into the State treasury, Feb. 15, 1893. As they have ceased to be available they are not included in the total balance.

Statement D is a statement of account with the donation received from Wayne county:

STATEMENT D.

OHIO AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH DONATION FROM WAYNE COUNTY.

RECEIPTS.

Unexpended balance brought forward July 1, 1892	$26,371 85

EXPENDITURES.

1893.			
June 30, for land		$2,900 00	
"	buildings and repairs of buildings	14,533 87	
"	fencing	942 97	
"	drainage	2,867 66	
"	fruit and forest tree planting	385 16	
"	interest on building contract	[3]361 70	
Total expenditures			$21,991 36
By balance carried forward			4,380 49
Total			$26,371 85

([3]) On account of the pending litigation over the constitutionality of the law under which the Station was located in Wayne county, the State Auditor refused to honor the requisitions of the Board on the Wayne county donation, until authorized to do so by a special act of the legislature; by the time this act was passed, the above amount of interest had accrued on the contract for buildings.

The foregoing statements are all included in the following Statement E, which shows the total receipts and expenditures for the fiscal year :

STATEMENT E.

TOTAL RECEIPTS AND EXPENDITURES OF THE OHIO AGRICULTURAL EXPERIMENT STATION FOR THE YEAR ENDING JUNE 30, 1893.

RECEIPTS.

From U. S. treasury		$15,000 00	
"	farm produce, etc	8,542 71	
"	State appropriations for 1893	9,715 93	
Total receipts for the year			$33,258 64
Total balance brought forward July 1, 1892			28,789 99
Total			$62,048 63

EXPENDITURES.

For salaries	$9,680 00	
" labor	4,628 88	
" supplies	3,016 18	
" freight and expressage	425 12	
" tools and implements	1,078 85	
" live stock	3,278 75	
" fencing and drainage	3,813 54	
" furniture and general fittings	994 55	
" technical apparatus and supplies	250 42	
" library	80 90	
" printing, postage and stationery	982 92	
" travel and incidentals	540 16	
" buildings and repairs of buildings	14,588 66	
" land	2,900 00	
" fruit and forest tree planting	385 16	
" sub-station for field experiments	530 25	
" special work in entomology	57 30	
" fees of architect	1,000 00	
" expenses of Board of Control	462 29	
" interest	1,320 72	
Total expenditures for the year		$50,014 65
By balances lapsed		929 49
By total balance carried forward		11,104 49
Total		$62,048 63

(*) See foot-note page XIII.

LAND AND IMPROVEMENTS.

During the fiscal year, the following amounts have been expended for additions to the farm and for permanent improvements on the farm:

Land	$2,900 00
Buildings and repairs of buildings	15,944 46
Fencing and drainage	3,810 63
Fruit and forest tree planting	385 16
Total	$23,040 25

BERTHA E. WILDMAN, *Treasurer.*

REPORT OF THE DIRECTOR.

To HON. S. H. ELLIS, *President of the Board of Control:*

SIR: I have the honor of submitting herewith the twelfth annual report of the officers of the Ohio Agricultural Experiment Station:

THE SEASON.

During the months of April and May there were thirty-four rainy days, with a total precipitation at the Station of nearly twelve inches, which is about fifty per cent. above the eleven-year average for this section; but with June a drouth began which continued until October, the total precipitation for June, July, August and September being but sixty per cent. of the average rainfall. The result was that while the wheat and hay crops were better than the average, the yields of corn and oats were greatly reduced, corn especially being almost a total failure except on low lands.

THE STATION'S WORK AND PLANS.

The time and energy of the Station's staff have been so largely occupied in the work necessary to the proper equipment of the new farm that the regular work of the Station has suffered materially. The field experiments with fertilizers, hitherto conducted on the farm at Columbus, have been continued, through the coöperation of Prof. Thos. F. Hunt, Professor of Agriculture and Farm Superintendent, and Mr. F. P. Stump, Farm Foreman, of the State University. It is hoped that these experiments may be continued indefinitely. A similar, but more extensive series is being inaugurated on the Wayne county farm, and a few of the most important features of the work will be repeated on the farm in Fulton county, thus bringing under observation three characteristic soils of the State. It is greatly to be desired that this work should be extended so as to include at least the clays of the Western Reserve and of the great limestone region of the southwestern part of the State.

The experiments with varieties of cereals which have been a leading feature of the work of this Station since its first foundation are

fully inaugurated on the new farm, and on a more comprehensive and systematic plan than it has heretofore been possible to carry out.

Almost thirty acres of land have been prepared for field experiments with fertilizers; about fifty acres for variety testing of cereals, and about twenty acres for cultural work with cereals, making in all one hundred acres, all of which has been drained with tile drains laid thirty-six feet apart and thirty inches deep. In addition to this, considerable partial draining has been done, a total of twenty-six miles of tile drain having been laid during the summer.

The Station now possesses a much larger area of land suitable for grazing than it has heretofore had access to, and it is hoped that the live stock industry may hereafter be given the attention which its importance merits. Plans are being made for comprehensive experiments in dairying, cattle feeding and sheep husbandry, and it is hoped that by another year investigations may be in progress in all these lines.

About fifteen acres of land have been planted in fruits, and a considerable additional area will be devoted to the culture of potatoes and garden vegetables. These, in addition to the excellent greenhouse equipment now in operation, will put the Horticultural Department of the Station on a far better footing than it has ever before enjoyed.

The removal of the Station has caused less interruption to its entomological studies than to other lines of work. The new insectary, though small, is compact and well equipped, and a considerable amount of work has been done in various parts of the State.

The report of the Chemist will show that he has accomplished a considerable amount of chemical work, in addition to his duties as Meteorologist. It is hoped that this work in the future may add materially to our knowledge of the chemistry of Ohio soils and feeding stuffs.

FARMERS' INSTITUTES.

Under the able management of Secretary L. N. Bonham, of the State Board of Agriculture, the work of the farmers' institute is year by year increasing in interest and value. During the institute season one or more members of the Station staff have been constantly engaged in this work, and we feel that it is an effective medium through which the Station's work may be made useful to the farmers of the State.

LOCAL INTEREST.

The farmers of Wayne county are manifesting a lively interest in the Station's work. On several occasions they have been invited to visit the Station to inspect certain features of the work, to which they have responded in large numbers. While it must necessarily require

several years to get the farm into such condition that a visit to it can be of much service to the practical farmer, yet the work already done is sufficient to show that by the application to this work of the methods of husbandry followed by the excellent farmers of this region it may be made to yield results of very great practical value.

PUBLICATIONS.

The time of the executive officers of the Station has been so closely occupied during the year by the details of business that it was impossible to keep up to date in the publication of results, and only six bulletins have been issued since our last report. These are:

BULLETIN 48 (VOL. VI, NO. 1), FEBRUARY, 1893, BY W. J. GREEN.

Profit in spraying orchards and vineyards; containing formulæ for spraying mixtures, with practical directions for their application.

SUMMARY.

(1.) The profit to be derived from spraying orchards often exceeds $20 per acre, and for vineyards is much more. The fruit crop of the State would be enhanced in value by several million dollars annually if the practice were generally followed.

(2.) Combined fungicides and insecticides are recommended whenever applicable, because of a saving of time; a less liability of injuring foliage; greater efficiency in some cases, and as a precautionary measure in others.

(3.) Dilute Bordeaux mixture, copper-arsenic solution and ammoniacal solution of copper carbonate are the most useful for the treatment of the diseases herein mentioned and the first has the widest range of usefulness of all.

(4.) Early spraying is the key to success in the use of fungicides.

(5.) For the plum curculio and shot-hole fungus use Bordeaux mixture and Paris green combined, making three or four applications.

It is not known that this treatment will prevent the black knot, but cutting away and burning the diseased branches will accomplish the result.

(6.) Scabby apples rot much earlier than those free from scab, and spraying with fungicides will save at least 50 per cent. of this loss.

(7.) Spraying with fungicides in the season of 1892 prevented much of the early dropping of apples, which is usually attributed to wet weather.

(8.) For apples, two applications of Bordeaux mixture before blooming are advised, and two of the same mixture after blooming, with Paris green added.

(9.) The same treatment is recommended for the pear as for the apple, before blooming, but the copper-arsenic solution is advised after blooming.

(10.) The Bordeaux mixture, if used too late, causes a russet appearance on both pears and apples.

(11.) The quince may be treated the same as apples, or with Bordeaux mixture alone.

(12.) The treatment advised for the cherry consists in making two or three applications of Paris green, two ounces to fifty gallons of water.

(13.) Peach trees and American varieties of plums have very tender foliage, and must be treated with very weak mixtures, if at all.

(14.) Raspberries may be treated with Bordeaux mixture alone; grapes with the same until the fruit sets, after which use copper carbonate. Potatoes should be sprayed at least five times with Bordeaux mixture and Paris green.

BULLETIN NO. 3, VOL. I, TECHNICAL SERIES, APRIL, 1893.

Entomological and Botanical papers: This bulletin contains a number of technical, entomological and botanical papers published by coöperation of the Station with the Ohio Academy of Science. The titles of the papers are given on page XXIII.

BULLETIN 49 (VOL. VI, NO. 2), MAY, 1893, BY C. E. THORNE AND J. F. HICKMAN.

Field experiments with commercial fertilizers, including: Experiments on wheat at the Station, coöperative experiments on wheat, experiments on crops grown in rotation, experiments on oats at the Station, experiments on corn at the Station and coöperative experiments on corn.

SUMMARY.

The experiments of this Station with fertilizers now include four years' continuous culture of wheat on the same land, with and without fertilizers, on the farm hitherto occupied by the Station in Columbus and belonging to the State University; three years' similar culture of wheat in Columbiana county; four years' continuous culture of oats on the Columbus farm; five years' continuous culture of corn on the Columbus farm and in Columbiana county, and fourteen coöperative experiments, made in 1889, 1890, 1891 and 1892 by farmers in Ashtabula, Holmes, Miami, Huron, Licking, Butler and Washington counties, besides several years' study of crops grown in rotation and of plants grown in boxes.

These experiments must be continued further before positive conclusions can be drawn, but at the present date the following tentative conclusions seem to be justified:

(1.) The use of superphosphate and potash, separately or in combination, but without nitrogen, has frequently caused a loss of grain in crops of corn and wheat on soils deficient in vegetable matter.

(2.) The yield of straw or stalks has almost invariably been increased by the use of superphosphate.

(3.) The use of superphosphate has frequently, and that of potash has occasionally been followed by a considerable increase of crop, both of grain and straw or stalks, on sod ground or land containing an abundance of decomposing vegetable matter.

(4.) An increase of grain in the crop has generally followed the use of nitrate of soda, and this has happened in almost every case when the nitrate has been used in combination with superphosphate or potash.

(5.) When a complete fertilizer has been used, containing both phosphoric acid and potash, in combination with nitrogen, the phosphoric acid being carried in less active forms than bone-black superphosphate, an increase of crop has resulted in practically every case; but at present prices of fertilizers and grain respectively, this increase has invariably cost more than its value in the market.

(6.) While, therefore, these experiments demonstrate the possibility of producing a regular and certain increase in the yield of cereal crops by the use of a complete chemical fertilizer, yet they show that if such fertilizers are to be used with any prospect of profit in Ohio in the production of cereal crops and as

a part of a regular system of agriculture, that system must provide for the accumulation in the soil of the largest possible quantity of organic nitrogen, through the culture, in short rotations, of plants which have the power of obtaining nitrogen from sources inaccessible to the cereals.

BULLETIN 50 (VOL. VI, NO. 3), NOVEMBER, 1893; BY C. E. THORNE, J. F. HICKMAN AND F. J. FALKENBACH.

Experiments in feeding for milk, including a comparison of corn silage and field beets as food for milk production, a study of the comparative productive capacity of different cows, of the ratio between increase in live weight and production of butter fat, and suggestions as to possible improvements in milk production.

SUMMARY.

I. Our contrast of corn silage and field beets as food for milk production leads to the following conclusions:

1. The feeding of beets to milk cows has always increased the consumption of other foods and of total dry matter.

2. Beets have always produced an increase in the flow of milk and in the total yield of butter-fat, but this increase has never been sufficient to offset the additional consumption of food.

3. The cows have nearly always shown a greater average live weight while feeding on beets. A part of this increase was probably due to increased weight of the contents of the digestive tract, but a part seems to have been actual gain.

4. Beets have not diminished the amount of water drank, although fed in such quantity as to increase the watery contents of the food by 30 pounds per day.

5. Our experiments do not justify the assumption that the dry matter of beets is any more effective as a cattle food, pound for pound, than the dry matter of silage made from well matured corn containing 13 to 18 per cent. of grain.

6. In the region where the tests were made, and as the average of ten years' culture of corn and beets, side by side, two pounds of dry matter have been produced in the form of corn silage at a less cost than one pound of dry matter in the form of beets.

7. A question which our experiments suggest, but do not answer, is whether beets may be used with any greater advantage in comparatively small quantity and simply as appetizers.

8. While silage made from comparatively mature corn has shown the best results in general, our experiments suggest that silage should be made before the corn has reached full maturity.

II. The results of our study of the comparative productive capacity of different cows are as follows:

1. When fed a ration composed of about one-fifth to one-fourth grains and the remainder coarse foods of good quality, our cows and those of several other stations have produced an average of about $3\frac{1}{5}$ pounds of butter-fat to each hundred pounds of dry matter in the food, besides making a small gain in live weight.

2. In general, when this rate of production of butter-fat has been exceeded there has been a loss in live weight, and when the butter-fat has fallen below this rate there has been a gain in live weight.

3. Individual exceptions to this general rule show that while some cows may return a handsome profit on their food, others may be fed at an actual loss, even when both butter-fat and increase of live weight are counted at full value.

III. From a comparison of experiments made by several different stations we conclude that in the general average, full periods of fattening being compared with full periods of lactation, the increase in live weight from a given quantity of food seems to be about three times as great as the average yield of butter-fat from the same quantity of food; and that in the case of cows giving milk, increase in live weight may replace yield of butter-fat in the same general ratio, modified, however, by age, breed and advancement in lactation.

IV. The superior productiveness of individual cows in these tests and of the cows employed in the World's Fair test at Chicago demonstrates the possibility of achieving a great increase in average productiveness through intelligent selection and better feeding.

BULLETIN 51 (VOL. VI, NO. 4), DECEMBER, 1893, BY F. M. WEBSTER.

Descriptions of the Asparagus Beetle, the Western Corn Root Worm, the Broad Striped Flea-Beetle, the Blister Beetles, the Bag or Basket Worm, the Cabbage Aphis and the Apple Plant Louse, with chapters on "Some Insect Immigrants in Ohio," showing their lines of distribution, and "Insect Foes of American Cereals."

BULLETIN 52 (VOL. VI, NO. 5), DECEMBER, 1893, BY F. J. FALKENBACH.

Meteorological summary and index, included with the present report.

PAST PUBLICATIONS.

During the first six years of the existence of this Station (1882-88) its annual reports contained the full record of all its work. Of these annuals, the editions for 1882 and 1883 (First and Second reports) are exhausted, but there are still on hand a small number of the subsequent reports, which will be sent to any applicant on receipt of seven cents each for postage. The "first series" of the Station's bulletins, comprising those published prior to 1888, were chiefly issued in the form of newspaper slips. No file of them was preserved, and no copies can now be furnished.

The bulletins for 1888 comprise the first seven numbers of the "second series." They were published in small editions, and were fully incorporated in the annual report of that year. No copies of the bulletins can now be furnished, but there are still a few copies of the annual report.

Beginning with 1889, the bulletins have been published in complete form, and only abstracts have been republished in the annual reports. The supply of the first two issues for 1889 (the first treating on insects and insecticides, the second on the colic of horses) is exhausted, but a limited number of all issues since that date can be supplied.

Following are the titles of bulletins published separately from the annual reports:

No. 8 (Vol. II, No. 1), March, 1889.—Insects, insecticides and methods of collecting and studying insects.

No. 9 (Vol. II, No. 2), April and May, 1889—Colic of horses.

No. 10 (Vol. II, No. 3), June, 1889—Silos and ensilage. Silage and field beets as food for cows.

No. 11 (Vol. II, No. 4), July, 1889—Experiments with small fruits. Effect of early and late picking upon keeping quality of apples.

No. 12 (Vol. II, No. 5), August, 1889—Wheat: Cultural and variety tests.

No. 13 (Vol. II, No. 6), September, 1889—Insect remedies and prevention of potato rot.

No. 14 (Vol II, No. 7), November, 1889—Cabbage and cauliflower, and treatment of certain plant diseases.

No. 15 (Vol. II, No. 8), December, 1889—Annual report and meteorological summary.

No. 16 (Vol. III, No. 1), January, 1890—Experiments with potatoes.

No. 17 (Vol. III, No. 2), February, 1890—Field experiments with fertilizers.

No. 18 (Vol. III, No. 3), March, 1890—Experiments with corn and oats. Actinomycosis.

No. 19 (Vol. III, No. 4) April, 1890—Spraying to prevent insect injury. Insects affecting corn. Fungous diseases of plants. Collecting plants.

No. 20 (Vol. III, No. 5), June, 1890—Corn silage vs. sugar beets as food for milk production.

No. 21 (Vol. III, No. 6), July, 1890—Wheat: Cultural and variety tests.

No. 22 (Vol. III, No. 7), August, 1890—Strawberries and raspberries.

No. 23 (Vol. III, No. 8), September, 1890—The plum curculio, cucumber beetle, rhubarb curculio and clover stem borer. Potato blight.

No. 24 (Vol III, No. 9), October, 1890—Asparagus. Transplanting onions.

No. 25 (Vol. III, No. 10), November, 1890—Grape rot and corn smut.

No. 26 (Vol. III, No. 11), December, 1890—Annual report and meteorological summary.

No. 27 (Vol. IV, No. 1), January, 1891—Corn: Cultural, variety and fertilizer tests.

No. 28 (Vol. IV, No 2), February, 1891—Miscellaneous experiments in the control of injurious insects.

No. 29 (Vol. IV, No. 3), August 1, 1891—Fertilizers on wheat.

No. 30 (Vol. IV, No. 4), August 25, 1891—Wheat: Cultural and variety tests and treatment for smut.

No. 31 (Vol. IV, No. 5), September 1891—The wheat midge.

No. 32 (Vol. IV, No. 6), October, 1891—Experiments with small fruits. Diseases of the raspberry and blackberry.

No. 33 (Vol. IV, No. 7), November, 1891—The Hessian fly.

No. 34 (Vol. IV, No. 8), November, 1891—Forty years of wheat culture in Ohio.

No. 35 (Vol. IV, No. 9), December, 1891—Apple scab. The spraying of orchards.

No. 36 (Vol. IV, No. 10), December, 1891—Annual report and meteorological summary.

No. 37 (Vol. V, No. 1), January, 1892—Oats: Cultural and variety tests.

No. 38 (Vol. V, No. 2), February, 1892—Mangel wurzels and sugar beets.

No. 39 (Vol. V, No. 3), March, 1892—Fertilizers on corn and oats.

No. 40 (Vol. V, No. 4), April, 1892—Insects which burrow in the stem of wheat.

No. 41—Not published.

No. 42 (Vol. V, No. 5), August, 1892—Wheat: Cultural and variety tests.

No. 43 (Vol. V, No. 6), September, 1892—Greenhouses and greenhouse work. The food of the robin.

No. 44 (Vol. V, No. 7), September, 1892—The rusts of Ohio. Wild lettuce. Scab of wheat.

No. 45 (Vol. V, No. 8), December, 1892—Insects affecting the blackberry and raspberry.

No. 46 (Vol. V, No. 9), December, 1892—Underground insect destroyers of the wheat plant.

No. 47 (Vol. V, No. 10), December, 1892—Annual report and meteorological summary.

No. 48, February, 1893—Profit in spraying orchards and vineyards.

No. 49, May, 1893—Field experiments with fertilizers.

No. 50, November, 1893—Experiments in feeding for milk.

No. 51, December, 1893—Miscellaneous entomological papers.

No. 52, December, 1893—Annual report and meteorological summary.

These bulletins are published at irregular intervals, those issued during each calendar year being paged consecutively and indexed in the annual report for that year.

In addition to the publications named above, the Station is issuing a "technical series" of bulletins, designed for the publication of lines of investigation which, while not immediately useful to the farmer, yet indirectly serve the cause of agriculture by furnishing data and suggestions bearing upon methods of research. Of this series three numbers have thus far been issued, namely:

TECHNICAL SERIES, VOL. I, NO. 1, OCTOBER, 1889.

Article I.—Preparatory stages of the twenty-spotted Ladybird. (Illustrated.) ..... *C. M. Weed.*

Article II.—Studies in pond life. (Illustrated)..... *C. M. Weed.*

Article III.—A practical bibliography of insects affecting clover..... *C. M. Weed.*

TECHNICAL SERIES, VOL. I, NO. 2, MAY, 1890.

Article IV.—Flowering plants on the grounds of the Ohio State University ..... *Moses Craig.*

Article V.—Fourth contribution to the life history of little known plant lice ..... *C. M. Weed.*

Article VI.—Descriptive catalogue of the shells of Franklin county, Ohio. (Illustrated)..... *H. A. Surface.*

TECHNICAL SERIES, VOL. I, NO. 3, APRIL, 1893.

Article VII.—Methods of oviposition in the tipulidæ. (Illustrated).....*F. M. Webster.*

Article VIII.—A Dipterous gall-maker and its associates. (Illustrated.) ..... *F. M. Webster.*

Article IX.—Description of a new species of gall-making diptera. (Illustrated.) ..... *John Marten.*

Article X.—Description of a species of chlorops reared from galls on muhlenbergia mexicana ..... *S. W. Williston.*

These bulletins are paged consecutively, and a complete index will be published in the final number of the volume. The bulletins of this series are sent only to other stations, to public libraries, scientific societies, and to such individuals as expressly request them.

A limited number of these bulletins can be furnished to applicants.

The Station also publishes a "newspaper bulletin," containing brief summaries of its work, and distributed only to the press and to such persons as particularly request it. One hundred and thirty-two numbers have thus far been issued in this series. Back numbers cannot be supplied.

ACKNOWLEDGMENTS.

The publishers of the following journals have aided the Station in its work during the year, either by republishing abstracts from its bulletins or by donating their publications to its library:

AGRICULTURAL PAPERS OF OHIO.

American Grange Bulletin, Cincinnati.
Farm and Fireside, Springfield.
Farmer's Home, Dayton.
Gleanings in Bee Culture, Medina.
Ohio Farmer, Cleveland.

GENERAL PAPERS OF OHIO.

Arcanum Enterprise, Arcanum.
Ashtabula News, Ashtabula.
Attica Journal, Attica.
Auglaize County Democrat, Wapakoneta.
Bakersville Press, Bakersville.
Barnesville Republican, Barnesville.
Cincinnati Price Current, Cincinnati.
Columbus Record, Columbus.
Cortland Herald, Cortland.
Crestline Advocate, Crestline.
De Graff Buckeye, De Graff.
Democratic Herald, Delaware.
Democratic Record, Chardon.
Forest Review, Forest.
Fredericktown Free Press, Fredericktown.
Fremont Journal, Fremont.
Geauga County Record, Chardon.
Geauga Leader, Burton.
Greenville Democrat, Greenville.
Herald, Middleport.
Industrial News, Toledo.
Jacksonian, Wooster.
Kenton Graphic News, Kenton.
Leader, Chillicothe.
Lewisburg Reporter, Lewisburg.
Lodi Review, Lodi.
Malta Register, Malta.
Monroe Journal (German), Woodsfield.
New Concord Enterprise, New Concord.
Northern Ohio Journal, Painesville.
Ohio State Journal, Columbus.
Painesville Telegram, Painesville.
Plain City Dealer, Plain City.
Press, Columbus.
Republican Leader, New Lisbon.
Shelby News, Shelby.
Tuscarawas Advocate, New Philadelphia.
Tuscarawas Chronicle, Uhrichsville and Dennison.
Union County Journal, Marysville.
Valley Enterprise, Milford.
Wayne County Democrat, Wooster.
Wayne County Herald, Wooster.
Wood County Democrat, Bowling Green.
Wooster Journal, Wooster.
Wooster Republican, Wooster.

MISCELLANEOUS PAPERS.

Agricultural.

Acker und Gartenbau Zeitung, Milwaukee, Wis.
Agricultural Epitomist, Indianapolis, Ind.

Agricultural Journal, Montgomery, Ala.
Agricultural Gazette, New South Wales.
American Agriculturist, New York, N. Y.
American Gardening, New York, N. Y.
American Homestead, Omaha, Neb.
American Rural Home, Rochester, N. Y.
Breeders' Gazette, Chicago, Ill.
California Cultivator and Poultry Keeper, Los Angeles, Cal.
Canadian Entomologist, London, Ont., Canada.
Colman's Rural World, St. Louis, Mo.
Cultivator, Omaha, Neb.
Dakota Farmer, Huron, South Dakota.
Farm and Home, Chicago, Ill., and Springfield, Mass.
Farmers' Advocate, London and Winnipeg, Canada.
Farm, Field and Fireside, Chicago, Ill.
Farm, Stock and Home, Minneapolis, Minn.
Florida Agriculturist, De Land, Fla.
Fruit Growers' Journal, Cobden, Ill.
Grange Visitor, Lansing, Mich.
Hoard's Dairyman, Ft. Atkinson, Wis.
Home and Farm, Louisville, Ky.
Husbandman, Binghamton, N. Y.
Industrial American, Lexington, Ky.
Indiana Farmer, Indianapolis, Ind.
Journal of Agriculture, St. Louis, Mo.
Maritime Agriculturist, St. John, N. B.
Mirror and Farmer, Manchester, N. H.
National Stockman and Farmer, Pittsburgh, Pa.
Orange Judd Farmer, Chicago, Ill.
Pacific Rural Press, San Francisco, Cal.
Practical Farmer, Philadelphia, Pa.
Prairie Farmer, Chicago Ill.
Rural New Yorker, New York, N. Y.
Rural Northwest, Portland, Oregon.
Southern Cultivator and Dixie Farmer, Atlanta, Ga.
Southern Planter, Richmond, Va.
Stock and Farm, Bunker Hill, Ind.
Sugar Beet, Philadelphia, Pa.
Weekly Globe and Canadian Farmer, Toronto, Canada.
Western Breeder, St. Joseph, Mo.
Western Farmer and Stockman, Sioux City, Iowa.
Western Resources, Lincoln, Neb.
Western Swineherd, Geneseo, Ill.
Wisconsin Farmer, Madison, Wis.

General.

Baltimore Weekly Sun, Baltimore, Md.
Boston Globe, Weekly, Boston, Mass.
Clover Leaf, South Bend, Ind.
Detroit Free Press, Weekly, Detroit, Mich.
Kansas Weekly Capital and Farm Journal, Topeka, Kansas.
National Provisioner, New York, N. Y.

Press, The Weekly, New York, N. Y.
Press, The Weekly, Philadelphia, Pa.
Science, New York, N. Y.
University Record, Ann Arbor, Mich.
Union, The Weekly, Manchester, N. H.
World, The Weekly, New York, N. Y.

IMPLEMENTS, SEEDS AND PLANTS RECEIVED.

Thanks are returned for the following donations to the Station:

AGRICULTURAL DEPARTMENT.

Castleton, Silas, Pomeroy, Ohio, seed corn.
Cranze, Eugene F., Ira, O., seed oats.
Graves, T. J., Dana, Ind., seed corn.
Newark Machine Co., Columbus, O., one Monarch fanning mill and grader.
Northrup, Braslin & Goodwin Co., Minneapolis, Minn., seed corn.
Pray, J. L., Waterville, O., seed corn.

HORTICULTURAL DEPARTMENT.

Bigelow & Co., Chicago, Ill., Oriental fertilizer and insect destroyer.
Brewer, S. F., St. Louis, Mo., 1 variety strawberry.
Burpee, W. A. & Co., Philadelphia, Pa., several pkts. seeds.
Cowing, Granville, Muncie, Ind., 1 variety strawberry.
Crawford, M., Cuyahoga Falls, O., 19 varieties strawberry plants.
Dow, Geo. Q., North Epping, N. H., 1 variety strawberry plants.
Gregory, J. J. H. & Son, Marblehead, Mass., 8 varieties vegetable seeds.
Hall, J. W., Marion Station, Md., 1 variety strawberry plants.
Hall, M. O., Marion Station, Md., 1 variety strawberry plants.
Halladay, A. A., Bellows Falls, Vt., 1 variety tomato seed.
Harris, S. M., Moreton Farm, N. Y., package of iodine.
Henderson, Peter & Co., New York, N. Y., 3 varieties grape vines.
Hoover & Gaines Co., The, Dayton, O., 1 variety strawberry plants.
Ingraham, Edward F., West Chester, Pa., 1 variety strawberry plants.
Lee, C. and C. L., Burbank, O., fruit picker.
Lee, H. S. and A. J., Geneva, Pa., 2 varieties strawberry plants.
Louisville Spirit Cured Tobacco Co., Louisville, Ky., 1 can rose leaf.
Luther, A., Leeds, Mo., 1 variety strawberry plants.
McGowen, John J., Forest Home, N. Y., spraying nozzle.
McKinley, J. S., Orient, O., 1 variety grape vine.
Mills, Chas., Fairmont, N. Y., 2 varieties raspberry plants.
Myers & Bros., Ashland, O., spraying nozzle.
Nichols, A. M. & Son, Granville, O., 1 variety tomato seed and 1 variety strawberry.
P. C. Lewis Mfg. Co., Catskill, N. Y., spray pump.
Perfection Sprayer Co., The, Waterton, Ind., spray pump.
Poscharsky, F. W. & Son, Princeton, Ill., 1 variety strawberry plants.
Read, L. H., Grand Rapids, Wis., 1 variety raspberry plant; also tomato and potato seed.
Riehl, E. A., Alton, Ill., 1 variety strawberry plants.
Sanders, A., Sac City, Iowa, 1 variety strawberry plants.

Stahl, William, Quincy, Ill., 1 knapsack spray pump.
Stiers, V. C. Haydenville, O., 1 variety tomato seed.
Stoneroad, V. D., Lewistown, Pa., 3 varieties potatoes.
Swably, G., Tiffin, O., 2 varieties strawberry plants.
Van Orman, F. B., Lewis, Iowa, 1 variety potato.
Warren, S. H., Weston, Mass., 1 variety strawberry plants.
West Jersey Nursery Co., The, Bridgeton, N. J, 3 varieties strawberry plants.
Woodbury, David B., Paris, Me., pansy seed.
Young, Henry, Ada, O., varieties strawberry plants.

The Monarch mill we have used three seasons, and recommend it for the special work of grading wheat for seed. As a fanning mill it lacks speed, but as a grader we think it is not excelled.

In conclusion, I have the pleasure of reporting another year of earnest, harmonious effort on the part of all connected with the Station.

Respectfully submitted,

CHAS. E. THORNE,
Director.

REPORT OF THE AGRICULTURIST.

J. FREMONT HICKMAN.

Owing to the change of base of operations from Columbus to Wooster, and to the unprepared condition of our new farm, the investigations carried on by this department have not been as satisfactory as in former years. The change has been from a warm, gravelly, naturally well drained and productive soil, to a cold, poorly drained and only moderately productive one. This wide difference in conditions makes it all the more essential that the experiments in field work conducted there should be repeated here. Our work during the past year has therefore been mainly a repetition of the experiments conducted on the farm at Columbus, and may be classified as follows:

I. Tests of varieties, including wheat, oats, corn, sorghum and sugar beets.

II. Cultural work with cereals.

III. Field experiments with commercial fertilizers in continuous cropping and in rotation.

IV. Testing forage crops, especially as to their adaptability to this soil, and including trials of certain grasses and clovers.

TESTS OF VARIETIES AND CULTURAL WORK.

Wheat: Our wheat experiments consisted of (a) a trial of seventy-five varieties for comparison of yields; (b) seeding at different rates per acre, from two pecks up to ten pecks, duplicating the plots by seeding with a different variety; (c) seeding with graded and ungraded seed, and mixing varieties for seeding; (d) various methods of seeding, such as deep and shallow planting, rolling before drilling on some plots and after drilling on others, seeding with the hoe drill and shoe drill, broadcasting compared with drilling, harrowing in spring and mulching in fall; (e) weighing stored grain each month during a year to determine shrinkage.

Oats: (a) Sixty-four varieties of oats were used in a comparative test; a number of these were duplicated and about one hundred varieties were sown in small plots for the purpose of studying synonyms. (b) Plowing corn stubble vs. harrowing, as a preparation for seeding to oats; (c) deep and shallow planting of oats contrasted.

Corn: (a) The varieties of corn in the comparative test for 1893 were all of the dent class, thirty-one in number. Twelve varieties were planted for ensilage; some of these were special ensilage sorts, others common field varieties. In addition to these variety tests at home I have attempted to have a co-operative test made by a number of farmers, covering some twelve counties of the State, to each of whom four varieties were sent. The main object of this co-operative test is to determine the maturing of the several varieties upon representative soils of the State. (b) Experiments in methods of culture were as follows: (1) contrasting deep and shallow culture; (2) distribution of seed, including hill and drill planting; (3) testing vitality of seed by planting continuously seed from same parts of the ear.

A limited experiment in deep and shallow plowing for corn was conducted on a piece of very stiff sod.

Sorghum: Five varieties of sorghum were planted, but only two out of the five matured, the season being too short for the other three.

Sugar Beets: Five varieties of sugar beets were planted to determine their comparative value as to sugar content; these have been harvested, sampled and turned over to the Station chemist.

FIELD EXPERIMENTS WITH COMMERCIAL FERTILIZERS.

These have been continued on the farm of the Ohio State University, covering twenty-two plots each of corn, oats and wheat. In this work the Station now has the results of five successive crops each of wheat and oats, and six successive crops of corn, taken from the same land. In the same field thirty-five plots are occupied with a five-year rotation.

Experiments along the same line were begun on the new Station farm with corn last spring, but the wheat work was not begun until fall.

TESTING OF FORAGE CROPS.

This work has been given more attention this year than in previous years; more, however, with reference to their adaptability to our soil and climate than to their utility after they have been grown. The following were grown during the past season: five varieties of soja beans, one of spurry, one of rape and two varieties of cow peas. It is expected that a bulletin will be devoted to a few of these special crops.

Work has been begun on the growing of grasses of different varieties. A grass garden has been started in which five or six varieties of grass have been started and three or four sorts of clover; to these others will be added as the seasons come.

In seeding the wheat ground last spring, seven or eight mixtures of grass, and grass and clovers were sown. These mixtures included red

clover, mammoth clover, alsike, blue-grass, orchard grass, red-top and timothy.

FARM IMPROVEMENTS.

A large part of my time has been occupied during the year in superintending the construction of various farm improvements, as follows:

(1) About thirteen hundred rods of wire and picket fence were erected around the outside boundaries of the farm.

(2) An old "Pennsylvania" barn, about 40x80 feet in size, was entirely remodeled; this work included the raising of the barn about a foot; excavating the floor another foot and underpinning the foundation; inclosing the overshoot; putting down a grout and cement floor; putting in new stalls; adding a silo, a set of stock scales, and a water supply, including a new well, wind-mill and tank; re-grading the approach; excavating the barnyard and inclosing it with a tight fence, and constructing a cistern for liquid manure.

(3) A new stone range course and water table was put under the central brick farm house, and the entire course was covered with sheet copper to keep down the dampness. This work required skill, care and patience on the part of the workman, but it was successfully done.

(4) A stone culvert on the main drive between the central and east barn was begun but only partly finished when cold weather stopped the work.

(5) In addition to all the above, a little over twenty-six miles of tile drain have been laid on the farm; with the exception of five weeks in harvest, this work has demanded some attention and time every day from the middle of March to the middle of November. A part of a forthcoming bulletin will be devoted to some statements in detail concerning methods and cost of ditching.

In June thirty-two head of cattle (all steers), twenty-seven of them grade Short-horns and five grade Holsteins, were bought and put upon the farm, with a view to giving them all similar summer conditions preparatory to putting them into a feeding experiment during this winter. The cattle and barn are now ready, and the experiment will be carried on during the winter months.

FARM PRODUCTS.

In the following table is given the area of land occupied by the principal farm crops in 1893, the total and average yields per acre, and the price per unit in the local market at the close of the year. This table is given for future comparison with the general yields of the county

and state, as computed from the returns of the township assessors, and also as a record of prices:

Crop.	Acres.	Total produce.	Yield per acre.	Market price.
Wheat	50.5	1,220 bushels	24.0 bushels	$0.55
Wheat straw	.....	77 tons	1.4 tons	3.00
Oats	30.0	580 bushels	19.3 bushels	0.35
Oat straw	.....	30 tons	1.0 ton	3.00
Corn	25.5	540 bushels	21.1 bushels	0.40
Corn fodder (stover)	.....	39 tons	1.5 tons	3.00
Ensilage corn	16.0	104 "	6.5 "	.....
Hay, timothy	60.0	105 "	1.75 "	9.00
Hay, clover	24.0	32 "	1.33 "	8.00

The very low yields of the corn and oat crops, as shown in the above table, were due to the lack of rainfall.

REPORT OF THE HORTICULTURIST.

W. J. GREEN.

The work in the horticultural department during the year has been largely preparatory for future operations. The four greenhouses, each 20x100 feet, which were put up in 1892, remained in an unfinished condition during the winter. An attempt was made to heat two of the houses with stoves and a portable engine, but this was only partially successful, and some important experiments which had been begun at Columbus in sub-irrigation could not be completed as had been anticipated. Some lettuce and tomatoes were grown, but the experiments with these crops had to be abandoned. During the summer, heating apparatus was put in and benches erected. The houses thus far have been devoted almost wholly to experiments in sub-irrigation with lettuce, cauliflower, cucumbers, radishes, tomatoes, beets, strawberries, carnations, roses, smilax, sweet peas and violets. Thus far most of the work is progressing in a very satisfactory manner. No experiment is yet completed, but not a failure to grow any kind of plant by sub-irrigation has been made. As might be expected, some plants do better than others under this treatment, but all are more or less improved by it, while with some the crop is often doubled. The work will probably be sufficiently advanced by the close of winter to warrant the publication of a bulletin giving details of methods and results early in the summer.

The necessity of water-tight benches for sub-irrigation has led to some important inventions in this line. It is found that a water-tight bench can be constructed of non-rotting materials at a moderate cost above ordinary lumber benches. These improvements will also be described in the bulletin referred to. The houses have improved ventilators, water benches, a plentiful supply of hose, and water piped to convenient places. Although some improvements could be made in the erection of similar houses, they are well adapted to the purposes of experimentation, and may to some extent serve as models in construction.

The highest land on the farm was chosen for the location of orchards and gardens, and the following fruits were planted:

Apples, 231 trees, comprising 77 varieties.
Pears, standard and dwarf, 222 trees, comprising 72 varieties.
Plums, 199 trees, comprising 68 varieties.

Apricots, 5 trees, comprising 5 varieties.
Cherries, 75 trees, comprising 25 varieties.
Peaches, 147 trees, comprising 35 varieties.

Blackberries, 13 varieties, raspberries, 23 varieties, grapes, 43 varieties, also currants, gooseberries, buffalo berry, Rocky Mountain cherry, juneberries, and 100 varieties of strawberries, nearly half of which are new sorts that have been sent to the Station for trial. The total area in fruits is about fifteen acres.

All of the tree fruits were so arranged in planting as to admit not only of variety tests, but of experiments in spraying. The experiment of spraying to prevent fungous diseases gaining a foothold was commenced soon after the planting. Certain trees are to be sprayed several times each year, while others are to be left untreated, and the effect noted from time to time.

In the selection of varieties the leading kinds were first taken, and the newer ones added. Old, well known sorts of doubtful value were not included. In most cases three trees of each variety were planted, although this rule was not followed strictly.

A small nursery of both fruit and ornamental trees has been started from which to draw supplies as needed. The list of ornamental trees and shrubs includes upward of one hundred species and varieties. All of these will be needed on the grounds, and a considerable saving in cost will thus be effected, as the plants being small were purchased at low figures.

No fruit was grown except a few peaches, and some strawberries on plants set the previous autumn. A brief report of these varieties will be given in a bulletin soon to be issued. A number of varieties of potatoes were grown, and some fertilizer tests conducted, a report of which will be given in due time.

Considerable attention was given to the tomato crop, particularly with reference to methods of training. A comparison on a considerable scale was made between staked and unstaked tomatoes, and some valuable results obtained, which will be embodied in a bulletin. Staking was found to hasten the time of ripening, to increase the size and to reduce the amount of rot. The extra labor was more than paid for in the higher prices obtained, because of extra size and earliness.

Some work in spraying was carried on, but owing to lack of bloom there was not sufficient fruit to admit of any decisive results. The most striking fact noted was that the blister beetles, more commonly called "old fashioned potato bugs," are repelled by Bordeaux mixture. Wherever this compound was used thoroughly, the bugs left the potato plants and either attacked weeds or unsprayed potatoes. Considerable benefit was found in the use of the Bordeaux mixture on tomato plants in keeping the foliage healthy, although the rot was not prevented.

REPORT OF THE ENTOMOLOGIST.

F. M. WEBSTER.

Owing to the continued unsettled condition of affairs with reference to buildings and other necessary facilities for carrying out investigations of a nature demanding close attention and equipment for doing things at the proper time, considerable work cannot as yet be carried out. As an illustration, a few days delay in the completion of the benches in the insectary last spring wrecked nearly a whole years experiments in wheat insects. Later, however, I was enabled to carry out an experiment with the apple leaf plant louse, *Aphis mali* Fab., and settle a question that has been under consideration for a number of years, but a lack of proper facilities had prevented its completion. In the insectary, I was able to follow the migration of this insect of the orchard directly to both wheat and grasses, and thereby settle the fact of its change of food plant, to return again in the fall to oviposit on the apple trees.

The rearing of parasitic insects beneficial to agriculture and horticulture resulted in very gratifying success. Since the preparation of number 3, of the Technical Series, twelve species not previously known to science were reared, and notes and observations on their habits placed on record. These species are as follows: *Hexaplasta melanopus* Ashm., *Bracon fungicola* Ashm., *Bracon rhyssamati* Ashm., *Clinocentrus tarsalis* Ashm., *Pygostolus americanus* Ashm., *Phænocarpa fungicola* Ashm., *Mesoleptus fungicola* Ashm., *Meniscus 4-cinctus* Ashm., *Syntomophus americanus* Ashm., *Polyscelis websteri* Ashm., *Chrysocharis compressicornis* Ashm., and *Tetrastichoides lasiopteræ* Ashm. Notwithstanding the fact that black knot, *Plowrightia morbosa* is not caused by insects, except as they are instrumental in the distribution of the spores, quite a number of species were reared therefrom, one of them being the American plum borer, *Euzophora semifuneralis*, not previously reported from Ohio. In June a trip was made to the strawberry fields about Marietta in order to investigate the effect of a species of Aleurodes which had appeared in great numbers in some of these fields. It was found that while the insect bred on the plants, it did no harm, the injury attributed to it being caused by a lack of fertilization. Much time during the season was spent in the study of the Rose Chafer, *Macrodactylus subspinosus*, and it was

learned for the first time that the larvæ could develop in great numbers in fields of fall wheat. This investigation is as yet unfinished, and a full report can not now be made. Three entirely new corn insects were studied in Ashtabula county, viz., *Hadena fractilinea*, *Hadena misera* Gt., and *Crambus luteolellus* Clem.

The Western corn root worm, *Diabrotica longicornis* occupied considerable time, it being a new pest to the corn crop in Ohio. A trip over the C., H. & D. R. R., along the western part of the State, indicated its occurrence in destructive abundance for a considerable distance east of the Indiana line, throughout nearly the entire length of the State, and especially in the Miami valley.

A serious injury to grapes, especially the Worden variety, has developed in the vineyards along the lake shore east of Cleveland. A small, white larva attacks the roots and eats the bark to such an extent that the life of the vine is destroyed. On rearing these larvæ, the pest was found to be *Fidia viticida* Walsh., and, although the adult beetle has long been known to feed on the foliage of the grape, the larvæ have heretofore remained unknown. These larvæ resemble some of the strawberry root worms, and during the winter and early spring are found in the earth in the vicinity of the roots. The beetle is a small brown or chestnut colored insect that will probably be mistaken, by the unentomological, for the rose bug, although it is much smaller and the two are in no way related.

The appearance of the Asparagus beetle, *Crioceris asparagi*, in the vicinity of Cleveland was investigated, and so far as known, the only colony occurring in that vicinity was destroyed by the use of Pyrethrum.

Among the insects on which more or less extended observations have been made is a large bug, allied to the squash bug, and for which there is no common name (being *Euschistus variolarius* P. Beauv.), that proved quite injurious to ripening tomatoes by puncturing the skin and sucking the juices. Peaches were attacked in the same manner. The Clover Leaf Weevil, *Phytonomus punctatus*, was found to feed in the adult stage on both burdock, *Lappa officinalis*, and the bloom of the solidago or golden rod. The larvæ appeared to prefer the leaves of the white clover to those of the red.

The Grave Yard Beetle, *Otiorrhynchus ovatus*, was reared from larva found feeding on the roots of the blue grass.

A corn Bill Bug, *Sphenophorus parvulus*, Gyll. was observed destroying an entire field of corn in Ashtabula county in June, and under circumstances indicating that fall plowing might result in driving the pest from the fields before the crop was planted.

A small Flea Beetle, *Epitrix parvula* Fab., was observed depredating on tobacco in Hamilton county in August.

The Bag or Basket Worm, *Thyridopteryx ephemeræformis* Haw., has been especially injurious this season in southern Ohio—it does not occur

elsewhere in the State—and I have nothing new to record except that about North Bend it is parasitized to a limited extent by a Dipteron, probably a Tachinid, as I have found the pupa protruding from the lower or posterior end of the sack and somewhat resembling the anterior end of the pupa of the male Thyridopteryx, as the latter is first pushed forth, preparatory to the emerging of the imago. The same parasite, or what has the appearance of being the same, has also been received from Indiana.

The last legislature of Ohio appropriated $400 for the expenses of special investigations in entomology, which will enable the entomologist to visit localities and investigate different insects and their depredations in the field, and thus be better able to aid the farmer and fruit grower than has been possible to do heretofore.

F. M. WEBSTER,
Entomologist.

REPORT OF THE CHEMIST.

F. J. FALKENBACH.

The past year has been devoted mainly to the collection and analysis of feeding stuffs for use in feeding experiments conducted at the Station.

Analyses of six samples of milk were made in connection with a prize offered by the State Board of Agriculture.

Samples of water sent in by different parties were tested for actual ammonia, albuminoid ammonia, chlorine, solids at 100° C., solids at red heat and hardness. The analyses of these will be found in a table below.

Analyses were made of 108 samples of wheat grown on the Station farm. These will be published in a future bulletin.

The dry matter was determined in eleven samples of ensilage.

Six varieties of sorghum cane were tested for sugar.

Analyses were made of six varieties of sugar beet.

One sample of bone soup tested for amounts of solids, nitrogen and phosphoric acid.

One sample of beef tested for amounts of dry matter, nitrogen and phosphoric acid.

Several samples of Wayne county clays were analyzed. The results are given in a table following.

The analyses of water were made according to Wancklyn's process. Mr. Wancklyn's interpretation of the results of his mode of investigation is as follows:

1. Chlorine alone does not indicate the presence of filthy water.

2. Free and albuminoid ammonia in water without chlorine indicates a vegetable source of contamination.

3. More than five grains per gallon of chlorine, accompanied by more than .08 parts per million of free ammonia and more than .10 parts per million of albuminoid ammonia indicates that the water is contaminated with sewage, decaying animal matter, etc., and should be condemned.

4. Eight hundredths parts per million of free ammonia and one tenth part per million of albuminoid ammonia render a water very suspicious even without much chlorine.

5. Albuminoid ammonia, over fifteen hundredths parts per million, ought absolutely to condemn a water which contains it.

6. The total solids found in water should not exceed 40 grains per gallon (571.4 parts per million).

TABLE I.—ANALYSES OF WATER.

PARTS PER MILLION.

Number.	Actual ammonia.	Albuminoid ammonia.	Chlorine.	Solids at 100° C.	Solids at red heat.	Hardness.* Clark's degrees.)
44	.053	.130	3.00	118.00	58.00	3.02
47	.014	.180	45.00	500.00	320.00	14.10
48	.160	.260	142.00	1,165.00	500.00	29.80
49	.040	.076	67.00	498.00	313.00	13.90
50	.054	.170	5.00	297.00	122.00	14.20
55	.040	.220	12.00	200.00	145.00	4.10
56	.093	.140	26.00	145.00	75.00	4.40
61	.026	.030	4.00	235.00	90.00	11.10
62	.013	.070	32.00	595.00	225.00	14.40
63	.026	.160	57.00	500.00	255.00	13.00
64	.054	.100	6.00	450.00	120.00	9.10
65	.206	.980	58.00	640.00	135.00	10.13

*Degrees of hardness: 1°–5°, soft; 5°–10°, medium; 10°–15°, hard; 15° and above, very hard.

TABLE II.—ANALYSIS OF CLAYS FOUND IN WAYNE COUNTY.

PARTS PER HUNDRED.

	Combined water.	Silica.	Sesquioxide of iron.	Alumina.	Lime.	Magnesia.	Fixed alkalies.
Fire clay	15.66	48.43	2.86	17.02	11.23	3.79	.83
Shale	6.28	57.24	6.57	24.63	1.59	1.48	1.63
Feldspathic clay	12.70	46.06	1.15	38.42	.46	.15	1.03
Brown clay shale	12.57	45.20	1.00	39.67	.42	.27	61
Plastic clay	8.10	60.43	1.39	27.81	.65	.18	1.27
Clay	7.30	59.61	5.84	21.94	2.45	1.36	1.01
Clay	8.61	56.55	6.44	21.71	2.85	1.45	1.61

ERRATA.

Page 33. The yields of straw for 1889 on plots 10 and 15 should be 3,960 and 4,060, respectively.

Page 62. The temperature scale should read 20° instead of 30°; 30° instead of 40°, etc.

Page 82. Second line from bottom, for "already" read "always."

APPENDIX.

BULLETIN

OF THE

OHIO AGRICULTURAL EXPERIMENT STATION.

VOL. VI. SECOND SERIES. 1893.

CONTENTS.

BULLETIN

OF THE

OHIO AGRICULTURAL EXPERIMENT STATION.

VOL. VI, NO. 5. } SECOND SERIES. DECEMBER, 1893.
WHOLE NUMBER 52. }

METEOROLOGICAL SUMMARY FOR 1893.

BY F. J. FALKENBACH.

EXPLANATION OF TABLES.

The following tables contain statistics of temperature, rainfall, etc., for the year, and are compiled from data obtained by daily observations. T stands for "trace," less than .01 inch of daily rainfall. Temperature is given in degrees Fahrenheit.

Table I shows the daily rainfall at the station during the year in inches and hundredths.

Table II shows the daily mean temperature for 1893, and the normal mean temperature for each day, computed from six years' record.

Table III gives a comparison of the monthly mean temperature and rainfall for the Station and the State with the six years' average for the same.

Table IV shows the rainfall at the Station for each month during the last six years.

Table V contains the mean temperature, the highest and lowest temperature, with the range of temperature for each month; the number of clear, fair and cloudy days; the rainfall and prevailing direction of wind for both the Experiment Station and State.

Table VI contains the principal points of interest on temperature, state of weather, and rainfall for the Station, during the year, and a grand summary for six years.

Table VII contains the principal points of interest on temperature, state of weather and rainfall for the State during the year, and a grand summary for eleven years.

The statistics for the State and for this Station previous to 1893 are compiled from the publications of the Ohio Meteorological Bureau and State Weather Service.

It will be observed that the statistics for the Station relate to its present location in Wayne county, and therefore are not directly comparable with those published in former reports, which relate to observations taken at Columbus.

METEOROLOGY.—TABLE I.—RAINFALL.

DAILY RAINFALL AND MELTED SNOW FOR 1893, AT EXPERIMENT STATION.

	Jan.	Feb.	Mch.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.
1	.39	.76			1.26	.05		T				
2	.41	49				.05						T
3	T		.06	.96		.07	.12			.65		.40
4	T		.04			.68				.70		
5	.10	.75			.57	T			T			
6	.15	1.33				.08	.01		.06			
7	.25			.13			.07					
8			.10	T			.32					
9	.12	1.32	.12	T								
10	.18		.03	.40			.13					
11	T		.40	T				T				.30
12	.55	T	.03	.21	.22			.35	.08			
13	.05	.20		.06	.10		.30		.16	1.35	04	
14	.48	.25	.20	.13	.20		.11			1.60		
15	T		T	.50	.70	.30	.05					.40
16	.10		T		.99	.38	.13	.18				.20
17	T	.37			.42	.06	.03				T	
18	T	.05			.08			T	T		15	
19	.5	.15	68	.27								
20	.15	.08		.40	.25	.03				.10		
21	T	.40	.20	.05	T	.15		T			.40	
22	.04	T	.53	T		.66				.08	.05	.10
23		T	.05		.05				1.60			
24	.10		.05						.25			
25	.16	T		32			.02		.20			
26	T			.40	.57					.30		
27				.15				.60		.35	1.50	
28		.18				T	.06	.15		.05	.15	.10
29	.28			.84				.25			.20	T
30				.84	.57		T		.10		T	
31	.45				T							
Totals	4 01	6 33	1.89	5.66	6 28	2.51	1 38	1.53	1 81	5.18	2.49	1.50
Averages	.13	.23	.06	.19	.20	.08	.04	.05	.06	.17	.08	.05

METEOROLOGY.—TABLE II.—TEMPERATURE.

(N. stands for Normal Mean Temperature for 6 years)

	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		November.		December.	
	1893.	N.	1893.	N.	1893.	N.	1893.	N.	1893.	N.	1893.	N.	1893.	N.	1893.	N.	1893.	N.	1893.	N.	1893.	N.	1893.	N.
1	34	36	35	26	32	26	53	43	64	50	70	63	69	72	72	70	63	65	52	59	52	46	22	30
2	24	24	30	27	38	27	44	41	48	51	73	66	69	73	66	70	57	66	58	57	54	47	16	32
3	12	21	24	34	33	26	58	42	46	54	76	69	69	73	68	70	60	66	62	59	46	41	18	25
4	17	22	10	32	17	24	56	41	46	55	74	67	63	69	74	71	64	65	54	55	40	41	23	36
5	15	26	31	28	22	20	55	44	47	53	75	67	72	70	72	72	72	67	56	55	36	42	20	36
6	15	27	44	27	36	25	48	41	51	54	68	65	65	71	70	70	71	66	58	53	38	43	24	35
7	14	22	15	28	39	24	73	45	48	56	64	66	78	72	62	70	78	68	62	54	46	46	18	37
8	18	26	16	26	50	29	68	45	58	57	62	66	79	71	64	69	67	63	56	52	50	47	28	36
9	18	22	33	29	46	30	48	44	63	60	66	69	69	68	69	69	68	63	65	54	48	52	30	36
10	1	24	33	22	44	29	43	46	61	60	71	67	68	70	74	70	72	64	62	54	46	47	29	39
11	2	28	30	26	44	32	48	47	68	55	66	65	61	71	78	71	73	61	67	55	48	42	28	37
12	10	27	32	28	40	32	61	48	59	55	62	67	72	72	70	70	70	65	68	54	50	39	30	34
13	7	26	34	30	50	30	64	49	53	53	64	69	79	72	64	70	70	64	59	53	36	41	22	33
14	6	23	43	31	34	29	36	52	57	53	67	68	79	72	66	69	76	66	40	47	33	38	26	33
15	4	22	40	32	19	25	35	47	58	56	72	71	82	72	69	69	76	66	40	44	25	37	47	35
16	3	23	28	37	24	27	49	46	46	51	72	72	78	72	72	68	59	64	45	47	32	38	42	33
17	1	22	28	29	32	30	44	51	45	57	72	71	76	72	70	68	56	61	46	52	40	34	24	29
18	21	24	24	29	27	32	45	52	52	63	72	71	72	69	67	67	64	61	48	49	35	36	22	24
19	8	21	17	24	31	29	48	51	59	59	73	70	68	68	64	67	74	61	53	50	34	37	26	24
20	12	17	4	24	43	30	54	49	64	58	74	70	68	67	62	67	64	60	51	47	30	36	18	29
21	17	19	15	24	44	30	42	51	69	58	74	69	68	70	66	66	68	62	54	45	34	40	28	30
22	24	18	23	26	36	29	35	50	76	61	73	68	70	74	62	66	74	62	56	45	36	42	41	27
23	28	26	33	25	62	34	40	51	56	60	66	69	70	71	67	67	60	61	57	44	26	38	47	33
24	28	26	38	34	52	33	47	45	57	63	65	69	66	69	72	68	58	60	61	46	20	36	51	38
25	21	27	21	34	34	38	45	47	63	63	70	68	77	69	77	68	50	57	46	43	21	36	56	37
26	28	27	24	28	32	37	53	53	53	59	68	67	77	71	74	68	47	58	49	45	30	36	38	32
27	27	25	39	29	34	35	52	51	62	58	65	67	68	72	70	67	49	57	45	46	37	36	32	30
28	44	29	36	27	31	32	56	51	60	57	66	70	68	71	69	66	48	58	42	48	33	27	42	31
29	33	29	...	...	38	32	50	50	62	59	67	72	78	72	59	66	44	58	34	44	38	28	42	36
30	28	29	...	...	50	36	53	54	67	63	71	72	72	71	59	66	48	55	36	41	38	28	31	32
31	33	33	...	...	56	39	...	...	68	61	...	...	76	73	56	67	...	...	38	44	...	...	28	34
Daily mean	18	27	28	29	38	29	50.1	47.2	57.6	57.3	69.3	68.9	72	70.8	67.9	67.1	63.2	62.2	52.3	49.6	37.7	39	30.9	32.4

METEOROLOGY—TABLE III.

COMPARISON OF MEAN, TEMPERATURE AND RAINFALL FOR 1893 AT EXPERIEENT STATION.

	Jan	Feb	March	April	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Mean temperature at the station	18°	28°	38°	50.1°	57.6°	69.3°	72°	67 9°	63 2°	52.3°	37.7°	30.9°	49.3°
Six year average temperature at the station	27.6°	29.3°	34 2°	46 5°	56 3°	68.4°	70.2°	68.2°	62.0°	48.9°	39.5°	33.0°	49.7°
Mean temperature for the state	18°	29°	38°	50.2°	58.3°	70 6°	74.5°	70.7°	65 2°	53.7°	39.3°	32.7°	50.1°
Six year average temperature for the state	28.5°	32.6°	36.1	50.3°	58.9	70.4°	72.0°	70.0°	6 .6	50.9°	40.8°	34.8°	50 9°
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches	Inches.	Inches
Rainfall at the station	4.01	6 3	1.89	5.66	6.28	2 51	1 38	1.53	1.85	5.18	2.49	1.50	40.61
Six years average at the station	3.66	4.44	3.14	2.82	4.83	5.04	3 89	2.84	2.85	3.14	3.56	2.20	41.69
Mean rainfall for the state	2.56	5.13	2 09	6.37	4.97	3 34	2.49	2.17	1.57	4.24	2.09	2.61	39.63
Six years average for the state	3.20	3.58	3.23	3.17	4.41	4.30	3.45	3.26	2.76	2.79	3.35	2.23	39.79

METEOROLOGY.—TABLE IV.

MONTHLY RAINFALL FOR SIX YEARS AT WOOSTER.

Year.	January.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.	Total.
	Inches.	Inches	Inches.	Inches	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
1888	3.52	2.43	3.34	2 48	3.82	2.31	4 54	4.35	1 92	3.18	4.95	1.39	38.25
1889	4.33	2.42	2.13	1.58	2 97	4.86	6.73	1.98	4.05	1.36	3.53	3.93	39.87
1890	4.71	6.20	4.37	3.10	6.01	5.57	2.67	4.66	5.12	7.45	2.61	1.74	54.21
1891	2.74	4.83	3.71	1.66	2.24	7.13	3.28	1 85	0.94	1.33	5.73	2.92	38.36
1892	2.67	.....	3.38	2.44	7.69	7.89	4.73	2.69	3.20	0.37	2.06	1.74	38.86
1893	4.01	4.33	1.89	5.66	6.28	2.51	1.38	1.53	1.85	5 18	2.49	1 50	40.58
Averages	3.66	4.44	3.14	2.82	4.83	5.04	3 89	2.84	2 85	3.14	3.56	2.20	41.69

METEOROLOGY.—TABLE V.—SUMMARY BY MONTHS FOR 1893.

	Temperature.											Number of days.						
	Mean.	Highest.	Date.	Lowest.	Date.	Range.	Mean daily range.	Greatest daily range.	Date.	Least daily range.	Date.	Clear.	Fair.	Cloudy.	Rain fell.	Monthly rainfall.	Average daily rainfall.	Prevailing wind.
At the Station.																		
January	18	51	28th.	—9	11th.	60	14	34	26th.	3	24th.	2	8	21	18	4.01	.13	S. W.
February	28	47	1*	—2	20th.	49	15	32	7th.	3	11th.	5	7	16	13	6.33	.23	W
March	38	75	23d.	10	16th	65	16	40	24d.	4	22d.	5	12	14	13	1.79	.06	S W.
April	50 1	83	7th.	24	15th.	59	16	31	7th.	5	10th.	5	12	13	15	5.66	.19	S. W.
May	57.6	84	22d.	36	24th.	48	17	32	24th.	3	26th.	9	9	13	13	6 28	.20	S W.
June	69.3	92	19th.	45	8th.	47	24	38	19th.	10	2?d	8	22	0	11	2.51	.08	S. W.
July	72	95	2*	47	4th.	48	28	40	28th.	16	26th.	10	20	1	12	1.38	.04	S. W.
August	67.9	93	10th.	37	31st.	56	29	45	9th.	8	2?th.	9	20	2	5	1.53	.05	N. W.
September	63.2	95	7th.	28	29th.	67	26	40	4th	11	16th.	8	22	0	7	1 85	.06	N. W.
October	52.3	85	11th.	24	31st.	61	24	38	18th.	6	13th.	15	12	4	9	5 15	.17	S
November	37.7	66	7th.	15	25th.	51	17	40	7th.	7	28th.	13	10	7	7	2.49	.08	W.
December	30.9	62	25th.	6	3*	56	16	29	16th.	6	22d.	7	10	14	6	1.50	.05	S. W.
Sums and averages	49.3	77.3		21.8		55.6	20.2	36.6		7		96	164	105	129	40.58	.11	S. W
For the State.																		
January	18	63	26th.	—24	1*	87	17	52	18th.	1	4th.	5	9	17	13	2.56	.08	W.
February	29	68	14th.	—14	21st.	82	18	47	2*	2	2d.	5	7	16	13	5.13	.18	W.
March	38	87	23d.	—8	16th.	95	21	50	25th.	2	3*	8	12	11	9	2.09	.07	W.
April	50.2	93	7th.	20	16th.	73	20	53	4th.	1	4*	5	10	15	16	6.37	.20	S W.
May	58.3	94	5*	23	7th.	71	23	49	20th.	1	6*	9	11	11	11	4.97	.16	S. W.
June	70 6	102	19th.	40	7*	62	24	46	19th.	2	6th.	16	12	4	9	3 34	.11	S W
July	74.5	101	16th.	42	8*	59	26	52	28th.	1	9*	15	13	3	8	2 49	.08	S. W.
August	70.7	101	26th.	37	31st.	64	26	54	9th.	3	17th.	16	11	4	6	2.17	.07	N. W.
September	65.2	100	7th.	24	10*	76	26	54	11*	3	20th.	13	12	5	5	1.57	.05	W.
October	53.7	95	11th.	15	28th.	81	24	50	12*	1	3d.	16	7	8	6	4.24	.14	S. W
November	39.3	76	9th.	2	26th.	74	20	45	5th.	2	8th.	10	9	11	7	2.09	.07	S. W.
December	32.7	72	24th.	—5	2d.	79	18	44	14th.	1	13*	6	10	15	10	2.61	.09	S. W.
Sums and averages	50.1	87.6		12.5		75.2	21.7	59 6		2		122	123	120	113	39.63	.11	S. W.

Station—*1—3, 10, 15. *2—7, 25. *3—17, 31.
State—*1—11, 15. *2—7, 26. *3—10, 12, 13, 22. *4—22, 30. *5—14, 20, 21, 22. *6—4, 17. *7—7, 19, 23. *8—2, 4, 11, 21. *9—1, 4, 9. *10—26, 29. *11—5, 6. *12—2, 11, 12. *13—16, 21, 26.

METEOROLOGY.—TABLE VI.

SUMMARY BY YEARS AND GRAND SUMMARY FOR SIX YEARS.

	1888.	1889.	1890.	1891.	1892.	1893.	Summary for six years.
At	*Wooster.*	*Wooster.*	*Wooster.*	*Wooster.*	*Wooster.*	*Experiment Station*	
Mean temperature	47.6°	48.6°	49.5°	50°	50°	49.3°	49.7°
Highest temperature		91.50, *1	94.5°, Aug 3	99°, Aug. 8	98°, July 25	95°, *5	99°, Aug. 8, '91.
Lowest temperature	—5°, Feb. 9	—5°, *2	1°, March 7	0°, March 1	—20°, Jan 20	—9°, Jan. 11	—20°, Jan. 20, '92.
Range of temperature		96.5°	93.5°	99°	118°	104°	119°.
Mean daily range of temperature		18.7°	18.9°	21°	19°	20.2°	19.6°.
Greatest daily range of temperature		42°, April 23	41°, Jan. 13	42°, Sept. 23	46°, July 7	45°, Aug. 9	46°, July 7, '92.
Least daily range of temperature		2°, January 6	4.5°, *3	4°, Feb. 8	4°, *4	3°, *6	2°, Jan. 6, '89.
Number of clear days		125	109	116	116	96.	112.
Number of fair days		103	119	110	123	164	124.
Number of cloudy days		137	137	125	98	105.	120
Number of days rain fell		119	149	119	119	129	127.
Total rainfall	38.25 inches	39.87 inches	54 21 inches	38.36 inches	38.86 inches	40. 58 inches	41.69 inches.
Greatest monthly rainfall	4.54 inches	6.73 in. July	7.45 in. October	4.26 in. June	7 89 in. June	6.33 in. Feb	7.89 in June, '92.
Least monthly rainfall	1.39 inches	1 36 in. October	1.74 in. Dec	1.95 in. April	3 37 in. Oct	1.38 in. July	0.37 in. Oct., '92.
Prevailing direction of wind	S.	S.	S.	S	S. W.	S. W.	S.

*1 July 10th, September 1st. *2 February 23d and 24th. *3 January 8th, September 10th. *4 March 5th, November 1st, 3d and 25th, December 1st and 18th. *5 July 7th and 25, September 7th. *6 January 24th, February 11th, May 26th.

Note—The Experiment Station is located one mile south of Wooster, and two miles south of the point at which observations were taken previous to 1893, at about the same elevation. Temperatures were taken in Wooster in 1893.

METEOROLOGY.—TABLE VII.—SUMMARY BY YEARS AND GRAND SUMMARY FOR ELEVEN YEARS.

FOR THE STATE.

	1883.	1884.	1885.	1886.	1887.	1888.
Mean temperature	49.4°	50.6°	48.0°	49.6°	51.4°	49.5°.
Highest temperature	98°, Aug. 22	99.0°, Sept. 28 and Oct. 1	101.0°, July 21	98.6°, July 7	108.0°, July 18	102.0°.
Lowest temperature	—17.2°, Jan. 22	—34.0°, Jan. 25	—31.0°, Jan. 29	—21.5°, Jan. 12	—21.0°, Jan. 7	—15.0°, Jan. 27.
Range of temperature	115.5°	133.0°	132.0°	120.1°	129.0°	117°.
Mean daily range of temp	19.8°	20.5°	20.4°	20.2°	21.2°	19.6°.
Greatest daily range of temp	55.2°, March 18	50.0°, Sept 5 and Dec. 4	58.5°, Jan 30	57.0°, Dec. 11	57.0°, April 11	50.0°.
Least daily range of temp	0.5, Dec. 23	1.1°, Feb. 6	1.0°, April 18 and Dec. 31	1.1°, March 27	1.0°, Jan. 15 and Apr. 16	1.2°, Jan. 16.
Average number of clear days	98.2	116.7	103.5	118.4	113.8	108.7.
Average number of fair days	135.4	118.3	132.8	125.7	127.3	123.4.
Average number cloudy days	130.4	131.1	128.2	121.0	123.9	133.9.
Average number days rain fell	146.0	145.0	147.7	130.7	126.9	124.7.
Mean yearly rainfall	44.98 inches	40.19 inches	38.08 inches	36.71 inches	33.63 inches	39.64 inches.
Mean daily rainfall	0.123 inch	0.110 inch	0.104 inch	0.100 inch	0.092 inch	0.108 inch.
Prevailing direction of wind	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.

	1889.	1890.	1891.	1892.	1893.	Summary for 11 years.
Mean temperature	51.1°	52.4°	52°	50°	50.1°	50°.
Highest temperature	99.5°, Aug. 31	103.1°, Aug. 3	101°, Aug. 10	103°, July 25	102°, June 19	108°, July 18, 1887.
Lowest temperature	—13.5°, Feb. 24	—4°, March 7	—5°, March 5	—25°, Jan. 20	—24°	—34°, Jan. 25, 1884.
Range of temperature	113.0°	107.1°	106°	128°	126°	142°.
Mean daily range of temp	19.3°	19°	20°	19°	21.7°	20.8°.
Greatest daily range of temp	53.0°, March 30	49.5°, April 11	50°, April 27 and 30	51°, Sept. 25	54.6°	58.5°, Jan. 30, 1885.
Least daily range of temp	1.0°, Jan. 5	1.0°, Dec. 17	2°[1]	1°[2]	1°	0.5°, Dec. 23, 1883.
Average number of clear days	112.8	103.4	133	111	122	113.
Average number of fair days	113.8	121.6	109	126	123	123.
Average number cloudy days	138.4	140.3	137	129	120	130.
Average number days rain fell	114.8	149.4	120	121	113	130.
Mean yearly rainfall	33.53 inches	50.33 inches	38.61 inches	37.16 inches	39.63 inches	39.40 inches.
Mean daily rainfall	0.092 inch	0.138 inch	0.11 inch	0.10 inch	0.11 inch	0.11 inch.
Prevailing direction of wind	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.

*1 Jan. 4th and 11th. March 19th and 22d. November 12th. December 4th.
*2 July 29th. November 3rd, 12th and 28th. December 17th.

NOTES ON THE WEATHER AT THE STATION.—SUMMARY BY MONTHS.

JANUARY.

The mean temperature was 18°, 9° below the old station average for January. The highest temperature, 51°, occurred on the 28th; the lowest, —9°, on the 11th.

Fair weather prevailed, rain and snow fell on 18 days.

The total precipitation for the month was 4.01 inches, which is .36 inch above the station average for January.

The prevailing wind was southwest.

FEBRUARY.

The mean temperature was 28°, 1° below the station average for February. The highest temperature, 47°, occurred on the 3d, 10th and 15th; the lowest, —2°, on the 20th.

Cloudy weather prevailed. Rain and snow fell on 13 days. The total precipitation for the month was 6.33 inches, which is 1.89 inch above the station average for February.

The prevailing wind was west.

MARCH.

The mean temperature was 38°, which is 9° above the station average for March. The highest temperature, 75°, occurred on the 23d; the lowest, 10°, on the 16th.

Cloudy weather prevailed. Rain and snow fell on 13 days. The total precipitation for the month was 1.89 inches, which is .89 inch below the station average for March.

The prevailing wind was southwest.

APRIL.

The mean temperature was 50.1°, which is 2.9 degrees above the station average for April.

The highest temperature, 83°, occurred on the 7th; the lowest, 24°, on the 15th. Cloudy weather prevailed. Rain and snow fell on 15 days. The total precipitation for the month was 5.66 inches, which is 3.29 inches above the station average for April.

The prevailing wind was southwest.

MAY.

The mean temperature was 57.6°, which is .3° above the station average for May. The highest temperature, 84°, occurred on the 22d, the lowest, 36°, on the 24th.

Cloudy weather prevailed. Rain fell on 13 days. The total rainfall for the month, 6.28 inches, which is 1.77 inches above the station average for May.

The prevailing wind was southwest.

JUNE.

The mean temperature was 69.3°, which is .4° above the station average for June. The highest temperature, 92°, occurred on the 19th; the lowest, 45°, on the 8th. Fair weather prevailed. Rain fell on 11 days.

The total rainfall for the month was 2.51 inches, which is 1.94 inch less than the station average for June.

The prevailing wind was southwest.

JULY.

The mean temperature was 72°, which is 1.2° above the station average for July. The highest temperature, 95°, occurred on the 7th and 25th; the lowest, 47°, on the 4th. Fair weather prevailed. Rain fell on 10 days. The total rainfall for the month was 1.38 inches, which is 2.24 inches below the station average for July.

The prevailing wind was southwest.

AUGUST.

The mean temperature was 67.9°, which is .5° above the station average for August. The highest temperature, 93°, occurred on the 10th; the lowest, 37°, on the 31st. Fair weather prevailed. Rain fell on 5 days. The total rainfall for the month was 1.53 inches, which is 1.02 inch below the station average for August.

The prevailing wind was northwest.

SEPTEMBER.

The mean temperature was 63.2°, which is 1° above the station average for September. The highest temperature, 95°, occurred on the 7th; the lowest, 28°, on the 29th.

Fair weather prevailed. Rain fell on 7 days. The total rainfall for the month was 1.85 inches, which is 1.06 inches, below the station average for September.

The prevailing wind was northwest.

OCTOBER.

The mean temperature was 52.3°, which is 2.7° above the station average for October. The highest temperature, 85°, occurred on the 11th; the lowest, 24°, on the 31st. Clear weather prevailed. Rain fell on 9 days. The total rainfall for the month was 5.15 inches, which is 3.42 inches above the station average for October.

The prevailing wind was south.

NOVEMBER.

The mean temperature was 37.7°, which is 1.3° below the station average for November. The highest temperature, 66°, occurred on the 7th; the lowest, 15°, on the 25th.

Clear weather prevailed. Rain fell on 7 days. The total rainfall for the month was 2.49 inches, which is .61 inch below the station average for November.

The prevailing wind was west.

DECEMBER.

The mean temperature was 30.9°, which is 1.5° below the station average for December. The highest temperature, 62°, occurred on the 25th; the lowest, 6°, on the 10th and 11th. Cloudy weather prevailed. Rain fell on 6 days. The total rainfall for the month was 1.50 inches, which is 1.21 inches below the station average for December.

The prevailing wind was southwest.

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(Articles marked * are illustrated.)